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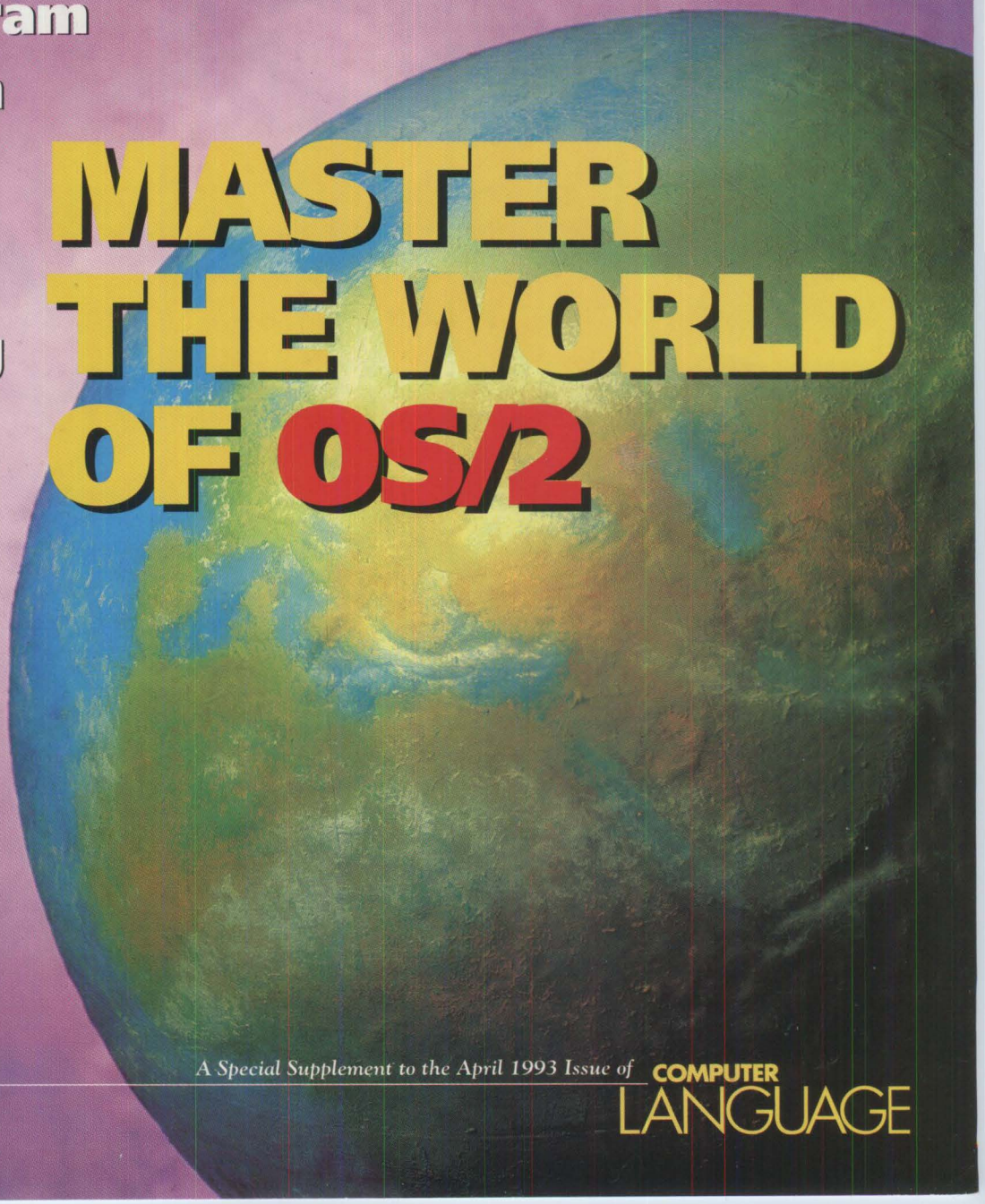

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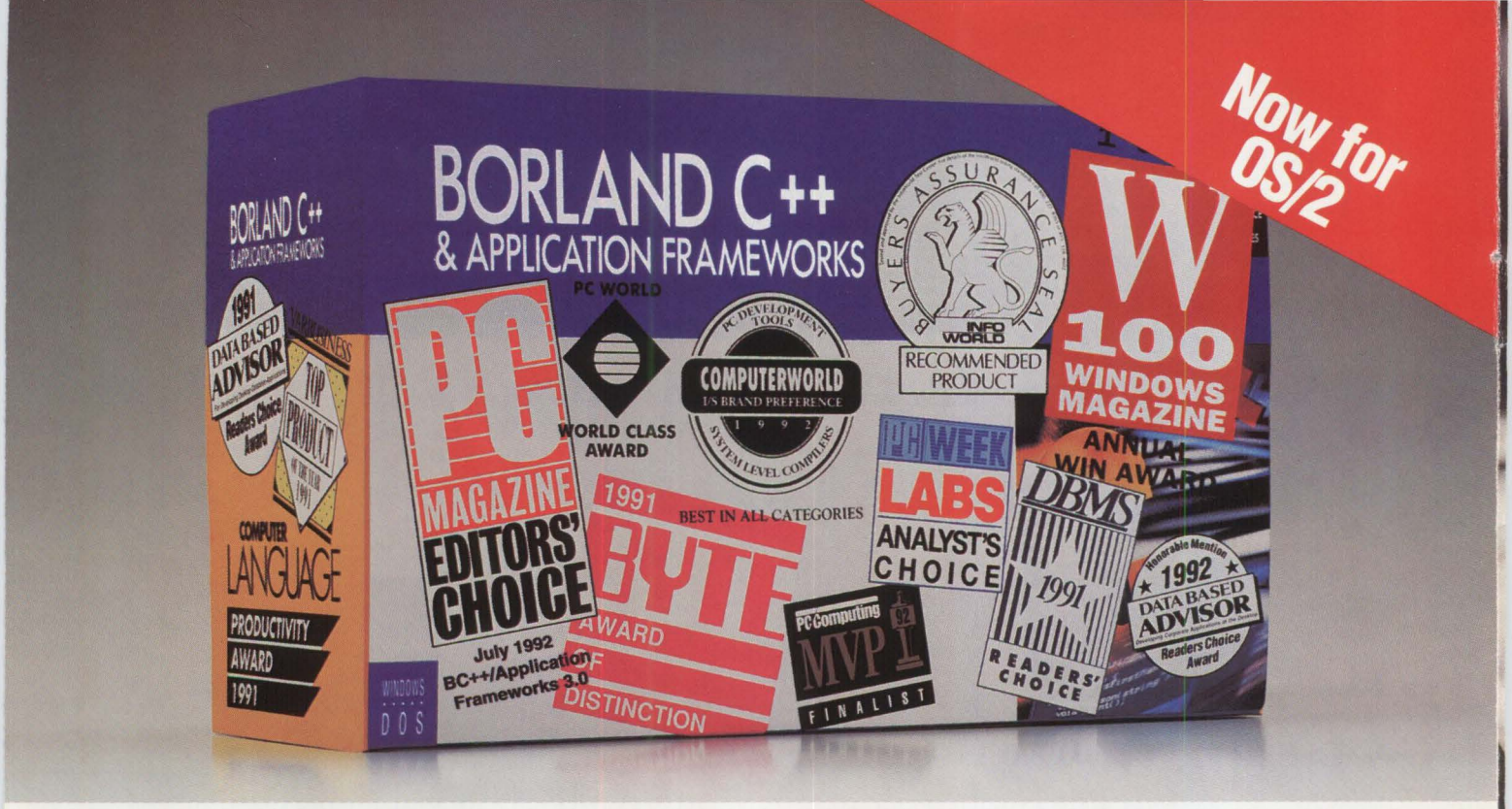

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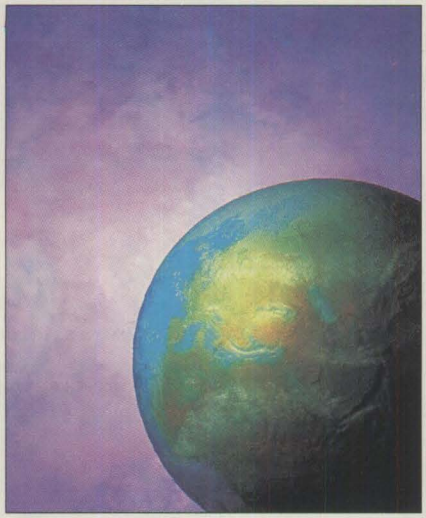

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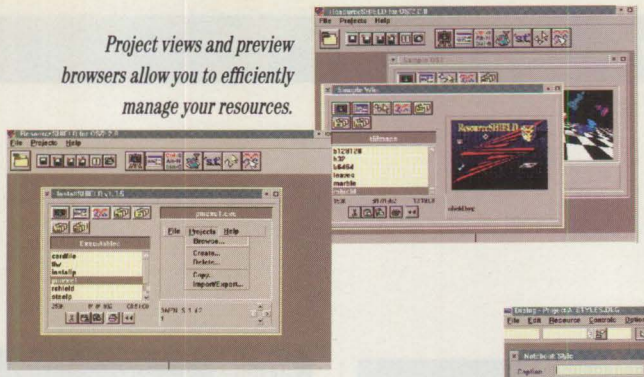

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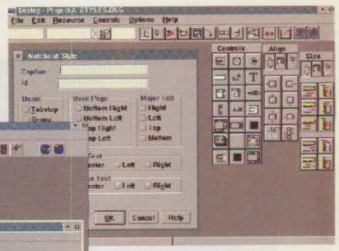

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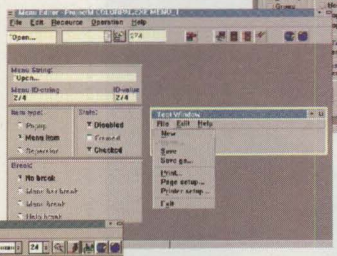

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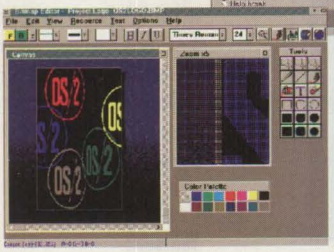

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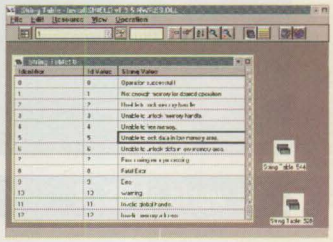

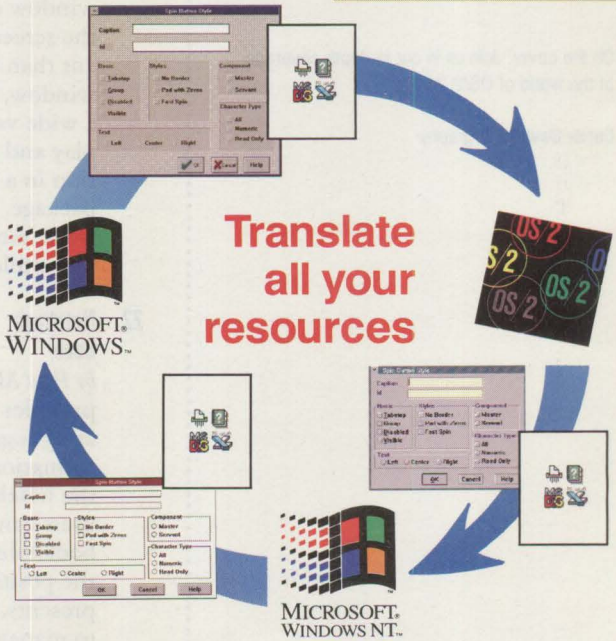

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Persistence pays off

It started in 1987 when IBM and Microsoft announced the OS/2 operating system. I won't bore you with the details. It is no secret that OS/2 1.x was not a stunning success. It did attract a following—a group of developers and users who saw and understood the promise.

OS/2 1.0 was missing the Presentation Manager. OS/2 1.1 shipped with Presentation Manager but we still couldn't print. OS/2 1.2 added the high-performance file system. OS/2 1.3 was finally small and agile enough to run on non-power-user systems. Fade out, fade in, and we get to OS/2 2.0—it could print, it had the Workplace Shell, it had promise! OS/2 2.1 adds more support for SCSI devices and CD-ROM (OS/2 2.1 is even distributed on CD-ROM). It has a fast 32-bit graphics engine, too.

But wait—there's more! A year or two ago, you wouldn't expect to read very much in some of the rumor columns about a small company developing an OS/2 product; it wasn't news—then. Yet, when something appeared recently, the phone at UCANDU Software Inc. in Carey, NC, started to ring. The company had almost 100 calls in two days. It seems a lot of people are interested in its Visual Programming with REXX tool—and the rumor said the product wouldn't be ready until April 1993.

Very often, it is the small, unknown companies that create the products that make the platform. Who had ever heard of Aldus before the Macintosh, Micrografix before Windows, or Microsoft before IBM. UCANDU Software is convinced.

For years, we've told anyone who would listen that small developers' companies were the future and hope for OS/2. We urged small developers to persist with their OS/2 development because we knew it would pay off. Many companies attended workshops we ran for IBM to help developers migrate their applications to OS/2 1.x and 2.0. Some of them were ready to beta test their 16-bit product by the end of the workshop week. Yet, their marketing departments decided there was a limited future. Today, other companies have filled the void; companies who persisted.

Small developers aren't alone; the roll call of large corporations using OS/2 2.1 in strategic ways is

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rapidly increasing. With the large numbers comes opportunities and demand for software. Wordperfect, Lotus, Borland, Symantec—all the major players have 32-bit OS/2 applications in the works.

IBM continues to upgrade the system to make it better. The first release included the Workplace shell, an object-oriented user interface. Buried under the covers was a technology called SOM (the System Object Model). SOM provides a way to describe objects that is independent of a programming language. Roger Sessions discusses SOM in "SOM Enchanted Evening...," starting on p. 7.

Any new system creates new issues for developers, in this case some new controls. It's possible to write whole volumes on the Container and Notebook controls. Randy Branham and Paul Montgomery provide an excellent introduction to these devices in "Container Yourself," starting on p. 16, and "Bene Notebook," starting on p. 22. Of course, no new operating system would be complete without a programming language. So, we asked Chris Cory to provide a review and comparison of both Borland International's C++ for OS/2 and IBM Corp.'s C Set/2 v. 2.0, starting on p. 27.

As I said, it started in 1987. Six years later we see evidence that persistence really does pay off. IBM listened; the result is OS/2 2.1. It is here, and it works. *COMPUTER LANGUAGE* editor Larry O'Brien and I talked about this supplement at Fall COMDEX. As a result, I requested contributions from a number of people I've had the good fortune to get to know. At deadline, we had more articles than space in this issue allows. The folks at *COMPUTER LANGUAGE* had to make some hard choices; the results can be found on the following pages. To everyone who worked with me to help put this together, "Don't give up, persistence pays off!"

David Moskowitz,
Supplement Editor

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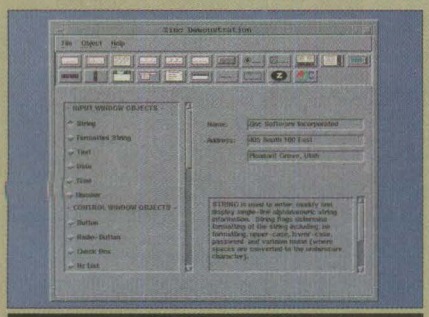

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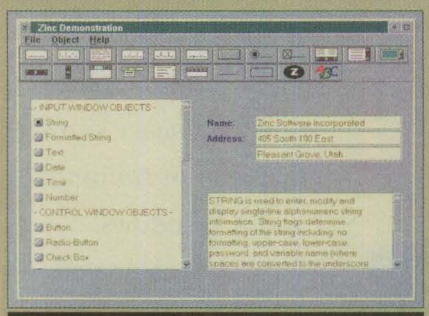

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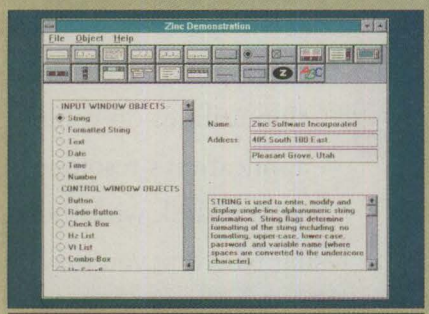

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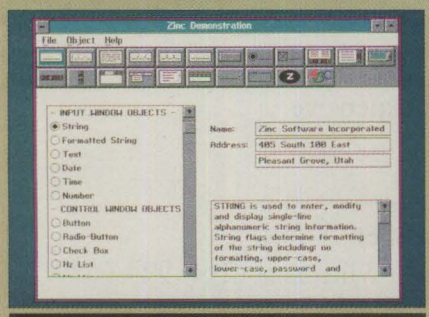

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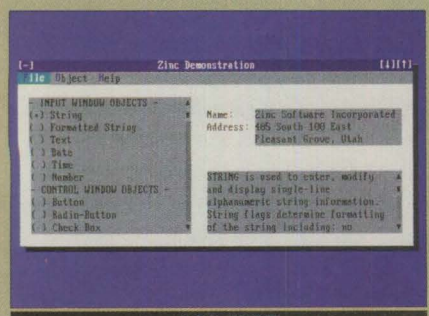

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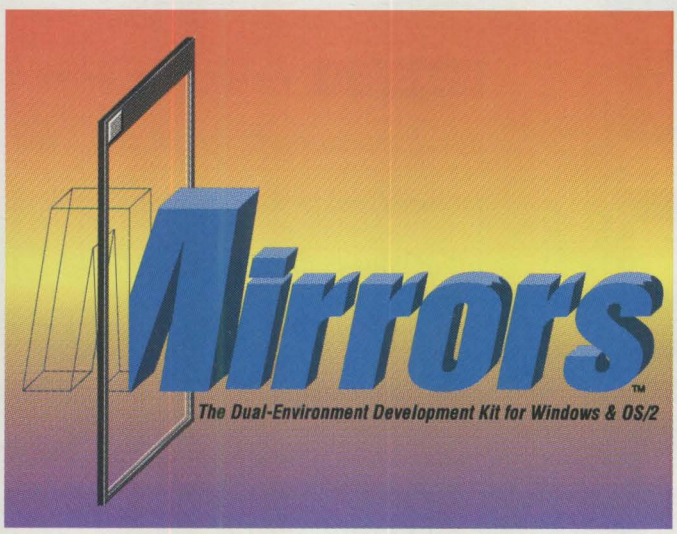

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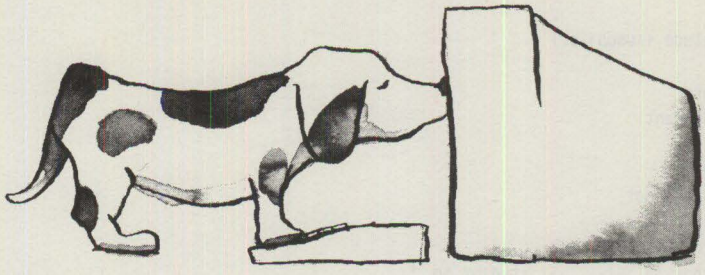
SOM Enchanted Evening...



Using OS/2 2.0's System Object Model will enhance existing object-oriented languages and bring object orientation to your procedural projects.

by Roger Sessions and Nurcan Coskun

Object-oriented programming is revolutionizing the way we write software. In object-oriented programming, we employ three major features: encapsulation, to write multipurpose and easily tested classes; inheritance, to improve code reuse; and polymorphism, to simplify code and reduce maintenance costs.[1]

SOM is an important technology designed to significantly enhance existing object-oriented programming languages and bring object-oriented capabilities to languages that are essentially procedural.[2,3]

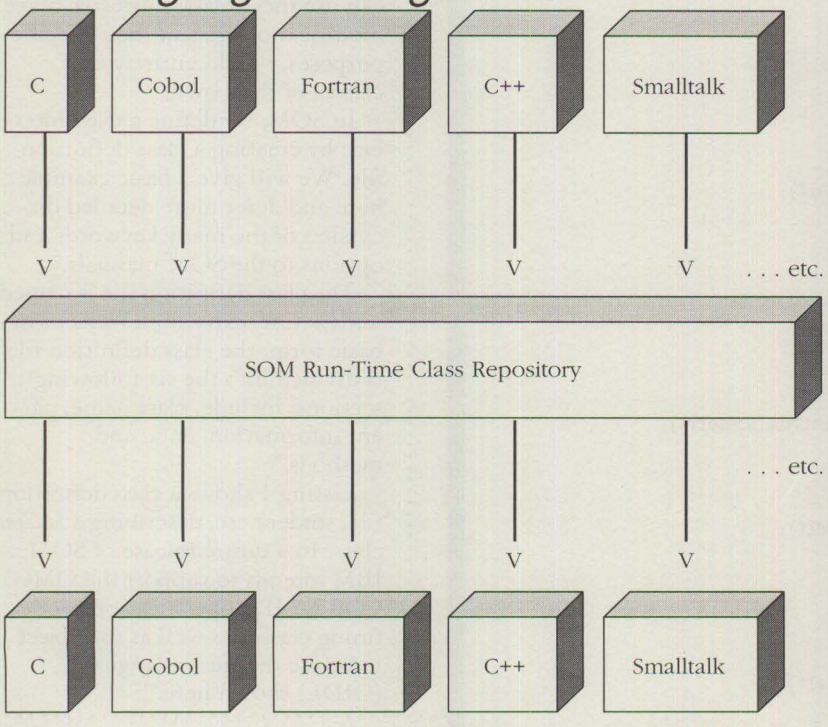
The most important feature of SOM and the one that most sets it apart from other object-oriented technologies is its language neutrality. SOM is designed to allow classes written in one language to be used from any other language. When we say these classes can be used, we mean this in the fullest possible object-oriented sense. The classes can be instantiated, manipulated, and, most important, subclassed. The only requirement is that both languages support SOM bindings.

The first set of language bindings is already available in the OS/2 2.0 toolkit for C. Additional language bindings under development include C++, Smalltalk, COBOL, and others.

IBM is actively encouraging various language vendors to directly support SOM bindings. IBM is also working with several different standardization bodies to make SOM as widely accepted as possible.

FIGURE 1.

SOM run-time class repository and language bindings



LISTING 1.

```
include <somobj.sc>

class:
  Student;

parent:
  SOMObject;

data:
  char id[16];    /* student id  */
  char name[32];  /* student name */

methods:

  void setUpStudent(char *id, char *name);
  --sets up a new student.

  void printStudentInfo();
  --prints the student information.

  char *getStudentType();
  --returns the student type.

  char *getStudentId();
  --returns the student id.
```

LISTING 2.

```
#define Student_Class_Source
#include ''student.ih''

static void setUpStudent(
   Student *somSelf, char *id, char *name)
{
   StudentData *somThis = StudentGetData(somSelf);
   strcpy(_id, id);
   strcpy(_name, name);
}
static void printStudentInfo(Student *somSelf)
{
   StudentData *somThis = StudentGetData(somSelf);
   printf('' Id       : %s \n'', _id);
   printf('' Name     : %s \n'', _name);
   printf('' Type     : %s \n'', _getStudentType(somSelf));
}
static char *getStudentType(Student *somSelf)
{
   StudentData *somThis = StudentGetData(somSelf);
   static char *type = ''student'';
   return (type);
}
static char *getStudentId(Student *somSelf)
{
   StudentData *somThis = StudentGetData(somSelf);
   return (_id);
}
```

The box in Figure 1, with C pointing to the run-time repository, represents a binding that allows classes to be defined in C and added to the SOM run-time repository. The box from the run-time repository to C is a binding that allows C to use classes from the repository regardless of the language in which the classes were originally written.

Because SOM is designed to work well with many languages and because it is focused on packaging issues, we think of SOM as packaging technology rather than language technology. The first major object-oriented library packaged with SOM, the Workplace Shell of OS/2 2.0, is already available.[4]

Defining classes in SOM

Creating class libraries in SOM using the C bindings is a three-step process. The class designer defines the class interface, then implements the class methods, and, finally, loads the resulting object code into a class library. Clients can use these classes directly, make modifications to suit their specific purposes, or add entirely new classes of their own.

In SOM, we define a class interface by creating a class definition file. We will give a basic example here and defer more detailed discussion of the many keywords and options to the SOM manuals.[5]

The class definition file is named with a .CSC extension. In its most basic form, the class definition file is divided into the six following sections: include, class name, parent information, data, and methods.[6]

Listing 1 shows a class definition file, student.csc, describing a *Student* class. In a future release of SOM, IBM intends to support the OMG CORBA IDL specification for defining classes as well as the object interface definition language (OIDL) shown here.[7]

Writing methods

Class methods are implemented in the class method implementation file. Each method defined in the method section of the class definition file must be implemented. The methods can be implemented in any language that offers SOM support, which for now is only C. The student class method implementation file, student.c, is shown in Listing 2.

The method code looks much like standard C, with a few differences. First, each method takes as its first parameter a pointer (*somSelf*) to the target object. This parameter is implicit in the class definition file but is made explicit in the method implementation.

Second, each method starts with a line setting an internal variable called *somThis*. This is used by macros within the SOM header file.

Third, names of data elements of the target object are preceded by an underscore character. The underscored name turns into a macro defined in the header file, part of the package SOM offers to shield method developers from the details of memory layout.

Fourth, methods are invoked using an underscore syntax. This underscored name turns into a macro invocation that shields programmers from having to understand the details of method resolution. Methods are always passed, as their first parameter, a pointer to the target object. This can be seen in the method *printStudentInfo()*, which invokes the method *getStudentType()* on its own target object.

The process of creating a class method implementation file can be greatly speeded up by the SOM compiler, which takes a .CSC file and generates a valid method implementation file lacking only the body of the methods. The body is then filled in by the class implementor. For the student example, the SOM compiler would create a file similar to that in Listing 3.

Deriving new SOM classes

Inheritance is an important mechanism for achieving code reuse in object-oriented libraries.[8]

In the following example, *GraduateStudent* is derived from *Student*, its base, or parent, class. A derived class automatically picks up all characteristics of the base class. A derived class can add new functionality through the definition and implementation of new methods. A derived class can also redefine methods of its base class, a process called overriding.

GraduateStudent adds *setUpGraduateStudent()* to those methods it inherits from *Student*. It overrides two other inherited methods, *printStudentInfo()* and *getStudentType()*. It inherits without changing *setUpStudent()* and *getStudentId()* from the *Student* base class. The class definition file for *GraduateStudent*, graduate.csc, is shown in Listing 4. The

LISTING 3.

```
#define Student_Class_Source
#include ''student.ih''

static void setUpStudent(
   Student *somSelf, char *id, char *name)
{
   StudentData *somThis = StudentGetData(somSelf);
}
static void printStudentInfo(Student *somSelf)
{
   StudentData *somThis = StudentGetData(somSelf);
}
/* ...and so on for the other methods. */
```

LISTING 4.

```
include <student.sc>

class:
  GraduateStudent;

parent:
  Student;

data:
  char  thesis[128];    /* thesis title */
  char  degree[16];     /* graduate degree type */

methods:
  override  printStudentInfo;
  override  getStudentType;
  void  setUpGraduateStudent(
      char *id, char *name, char *thesis, char *degree);
```

LISTING 5.

```
#define GraduateStudent_Class_Source
#include ''graduate.ih''

static void printStudentInfo(GraduateStudent *somSelf)
{
   GraduateStudentData *somThis = GraduateStudentGetData(somSelf);
   parent_printStudentInfo(somSelf);
   printf(''    Thesis     : %s \n'', _thesis);
   printf(''    Degree     : %s \n'', _degree);
}
static char *getStudentType(GraduateStudent *somSelf)
{
   static char *type = ''Graduate'';
   return (type);
}
static void setUpGraduateStudent(
   GraduateStudent *somSelf, char *id, char *name,
   char *thesis, char *degree)
{
   GraduateStudentData *somThis = GraduateStudentGetData(somSelf);
   _setUpStudent(somSelf,id,name);
   strcpy(_thesis, thesis);
   strcpy(_degree, degree);
}
```

LISTING 6.

```
#include ''student.h''
#include ''graduate.h''

main()
{
  Student *mark = StudentNew();
  GraduateStudent *jane = GraduateStudentNew();

  _setUpStudent(mark,''399542'',''Mark Smith'');
  _setUpGraduateStudent(jane, ''423538'', ''Jane Brown'',
              ''Code Optimization'',''Ph.D.'');
  _printStudentInfo(mark);
  _printStudentInfo(jane);
}
```

method implementation file for *GraduateStudent*, graduate.c, is shown in Listing 5.

Often, an overridden method will need to invoke the original method of its parent. For example, the *printStudentInfo()* for *GraduateStudent* first invokes the *Student* version of *printStudentInfo()* before printing out the *GraduateStudent*-specific information. The syntax for this is *parent_MethodName*, as can be seen in the *printStudentInfo()* method shown in Listing 5.

The SOM client

Now let's see how a client might make use of these two classes in a program. As we look at the program in Listing 6, we can discuss how objects are instantiated or created in SOM and how methods are invoked.

A class is instantiated with the method *classNameNew()*, which is automatically defined by SOM for each recognized class. Methods are invoked by clients just as they are inside SOM methods. The first parameter is the target object. The remaining parameters are whatever information is needed by the method. The only odd feature is the underscore preceding the method name that turns what looks like a regular function call into a macro defined in the .h file.

When run, this program gives this output:

```
Id       : 399542
Name     : Mark Smith
Type     : Student
Id       : 423538
Name     : Jane Brown
Type     : Graduate
Thesis   : Code Optimization
Degree   : Ph.D.
```

In the printout, we can see the override resolution at work in the different styles of output for *Students* and *GraduateStudents*. The *printStudentInfo()* method that a *Student* responds to is different than the method that a *GraduateStudent* responds to, as we can see from the preceding printout.

Class objects

Every class with at least one instantiated object has exactly one associated class object. Every instantiated object maintains a pointer to its class object, which it can retrieve through the method *somGetClass*. This method is inherited from *SOMObject*, a class from which every class is derived either directly or indirectly. In the program, *student1* and *student2* are both objects of class *Student*, and therefore both share the same class object. Similarly, *grad1* and *grad2* are both objects

of class *GraduateStudent*, and therefore both share another class object different than the class object shared by *student1* and *student2*. This relationship is shown pictorially in Figure 2.

In addition to accessing class objects via the *somGetClass* method, you can access a class object through the SOM-defined macro *_className*. For *Student*, this macro is *_Student*. This macro returns a pointer to the appropriate class object, if it exists, or zero, if it does not exist. SOM instantiates the class object the first time an object of its controlled class is instantiated. The *_Student* will, therefore, return zero if no *Student* objects have yet been instantiated.

The class object is quite a useful object. The class of a class object is either *SOMClass* or some class derived from *SOMClass*. A variety of methods are defined for *SOMClass*, and these are all documented in the class definition file for *SOMClass*, somcls.sc, and described in the SOM documentation. There are methods that show size of the class, parent of the class, whether the class is derived from some other class, and whether the class supports a specific method.

One of the *SOMClass* methods is *somGetName()*, which returns a pointer to a character string containing the name of the class for which this is the class object. For the *Student* class object, this string would be "Student". Another interesting *SOMClass* method is *somNew()*, which returns a newly instantiated object of the appropriate class. For the *Student* class object, the newly instantiated object would be of the *Student* class.

You can change the class of a class object through standard inheritance mechanisms. This is useful for adding the equivalent of C++ constructors and otherwise extending the capabilities of class objects.[9]

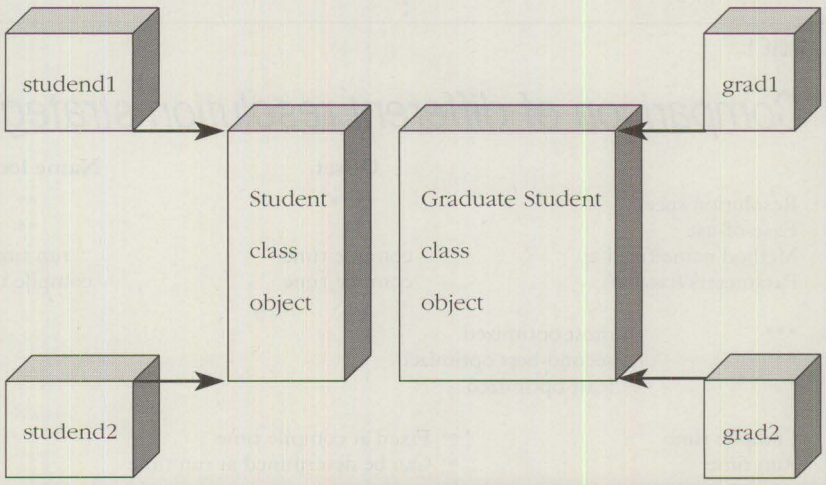
Method resolution

One of the features of SOM that allows bindings to be created for so many different languages is its concept of flexible method resolution.[10,11] This same flexibility can be exploited by the C programmer to choose the resolution most appropriate for a given task.

SOM supports three different method resolution strategies: offset, name lookup, and dispatch. If we compare flexibility, ease-of-use, and resolution speed, we find that each has a different optimization pattern. These differences are summarized in Table 1.

FIGURE 2.

Relationship between objects and class objects



This ability to choose from one of three resolution strategies is an important feature of SOM and allows SOM to be used in a wide variety of programming situations. At one end of the spectrum, SOM supports the highly efficient but inflexible offset resolution, similar to the virtual mechanism of C++.[12] At the other end, SOM supports the highly flexible dispatch resolution, allowing methods to be resolved when absolutely no compile time information is available.

Comparison to C++

In this section, we will compare some SOM features to those of the most widespread object-oriented programming language, C++.

SOM has many similarities to C++. Both support class definitions, inheritance, and overridden methods (called virtual methods in C++). Both support the notion of encapsulation. But where C++ is designed to support stand-alone efforts, SOM is primarily focused on the support of commercial quality class libraries. Most of the differences between SOM and C++ hinge on this issue.

C++ supports programming in only one language: C++. SOM is designed to support many languages. Rather than a language, SOM is really a system for defining, manipulating, and releasing class libraries. SOM is used to define classes and methods, but it is left up to the implementor to choose a language for implementing methods. Most programmers will, therefore, be able to use SOM quickly without having to learn a new language syntax.

C++ class libraries are version dependent. SOM class libraries are version independent. When a new C++ class library is released, client code has to be fully recompiled, even if the changes are unrelated to public interfaces.[13] SOM, unlike C++, directly supports the development of upwardly compatible class libraries.

C++ provides minimal support for implementation hiding or encapsulation. C++ class definitions, which must be released to clients, typically include declarations for the private data and methods. This information is, at best, unnecessarily detracting, and at worst, proprietary. In SOM, the client never has to see such implementation details. The client need see only the .sc files, which, by definition, contain only public information.

C++ has limited means of method resolution. SOM offers several alternatives. Like C++, SOM supports offset method resolution, meaning that methods are located via offsets in dispatch tables that are set up once and for all at compile time.

Unlike C++, SOM also offers facilities for resolving methods at run time. Name lookup resolution lets a client ask for a pointer to a method by method name. Dispatch resolution allows a client to package parameters at run time for dispatching to a method, a technique that allows SOM to be integrated into interpreted languages, such as Smalltalk.

SOM and C++ differ in their notion of class. In C++, the class declaration is very similar to a structure declaration. It is a compile-time package with little run-time significance. In SOM, the class of an object is an object in its own right. This object is an instantiation of another class, called the metaclass. The class object supports a host of useful methods that has no direct parallels in C++, such as *somGetName()*, *somGetParent()*, and *somFindMethod()*.

SOM should not be seen as a competitor to C++, but as an enhancement to C++. When C++ bindings are available, C++ programmers will be able to package their C++ classes to give them language independence and the other advantages of SOM packaged class libraries. ■

TABLE 1.

Comparison of different resolution strategies

	Offset	Name lookup	Dispatch
Resolution speed	***	**	*
Ease-of-use	***	**	*
Method name fixed at	compile time	run time	run time
Parameters fixed at	compile time	compile time	run time

*** = most optimized
** = second-best optimized
* = least optimized

Compile time = Fixed at compile time
Run time = Can be determined at run time

Acknowledgements

SOM is the work of many people. Mike Conner developed the initial idea and implementation and continues to lead the overall design of SOM. Andy Martin designed the SOM class interface language and designed and implemented the class interface compiler. Larry Raper implemented many features of the run-time library and ported SOM to OS/2. Larry Loucks provided close technical tracking and was instrumental in focusing the effort. Other SOM developers include Liane Acker, Nurcan Coskun, Scott Danforth, and Simon Nash. The project is managed by Jerry Ronga.

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13. Ibid.

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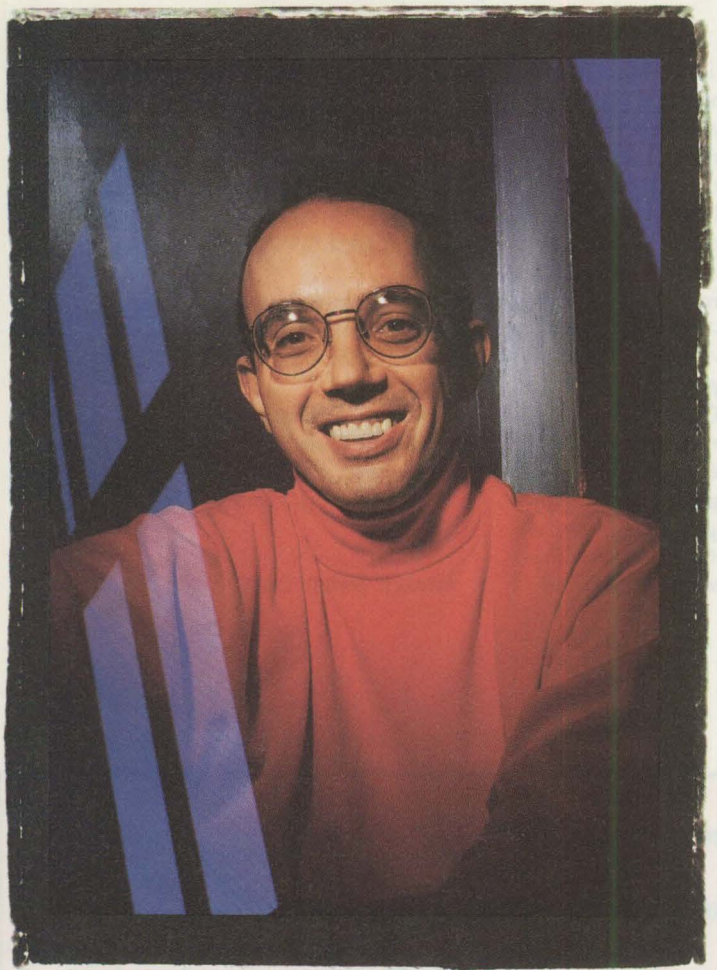
"Why I



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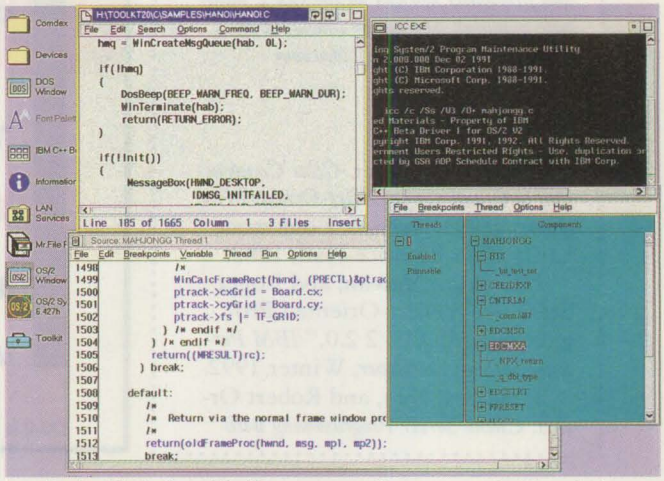

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Multitasking—Windows/PM apps	Cooperative	Pre-emptive
Priority	Static (set by user)	Dynamic
Dispatchability	Process	Thread
System services	Serial	Parallel
Protection between apps	Unprotected	Protected
Kernal protection—DOS/Win/PM apps	Unprotected	Protected
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Container Yourself!

OS/2's container control is a uniquely flexible and powerful way to hold and display your objects.

by Randy Branham

A container is an OS/2 2.0 system-provided control that holds and displays other objects. On the screen, it looks no different than any other standard window. But this is where looks can be deceiving. It is an extremely flexible window, offering a wide variety of views to display and manipulate information in a relatively simple package. With a little bit of work, anyone can use this control while programming.

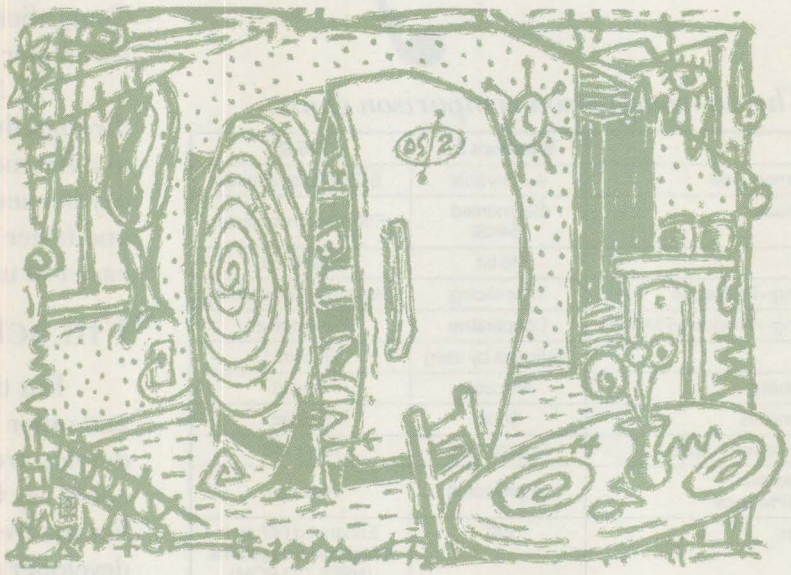
The creation of a container is rather easy. It's a standard window class that has some relatively simple attributes and styles. The styles control how objects within the container are selected, who positions the objects, whether the objects can be changed, and how we define the objects to the container. The attributes define how information is displayed within the container; whether it has titles, separators, and other lines; and who draws the container. Starting with this understanding, we're off to the world of programming containers.

Container styles

The styles are the first area of concern, and they effect the entire container. First, there are the selection styles: *CCS_EXTENDSEL*, *CCS_MULTIPLESEL*, and *CCS_SINGLESEL*. All these precipitate how objects within the container are selected, but all three have very different behavior. *CCS_SINGLESEL* allows only one object within the container to be selected at any time. The other two allow for differing types of multiple selection.

Second is the read-only style. *CCS_READONLY* prevents the user from opening edit windows anywhere within the container. If there is no user-modifiable data within the container, *CCS_READONLY* is very helpful. When we want the container to automatically position objects within it, we use *CCS_AUTOPOSITION*. This makes life a little easier when we're displaying simple text and icons.

The attributes define a little more about the container, titles, title positioning, and the appearance



LISTING 1.

```
hcont = WinCreateWindow( hwndparent
                  , WC_CONTAINER
                  , &CONTAINER_TITLE[0]
                  , CCS_AUTOPOSITION  CCS_EXTENDSEL
                  , 100, 100
                  , 100, 100
                  , hwndowner
                  , HWND_TOP
                  , id
                  , 0
                  , 0 );
```

LISTING 2.

```
WinSendMsg ( hcont
           , CM_SETCNRINFO
           , &cnrinfo
           , MPFROMLONG(CMA-CNRTITLE  CMA-FLWINDOWATTR));
```

of lines in one of the views. With *CA_CONTAINERTITLE* we can put a title within the container. This title appears on the top line and can be positioned to the left, right, or center, depending on *CA_TITLELEFT*, *CA_TITLERIGHT*, or *CA_TITLECENTER*. *CA_TITLEREADONLY* makes the title read-only. It is just like the control style CCS_READONLY, but it makes only the title read-only. If this attribute is not specified, the titles within the container can be edited and changed by the user, just like any other field, which can be particularly disastrous if it isn't planned for in advance.

Creating the container

Once the styles and attributes are chosen, the actual creation of the container is relatively easy. By choosing the *WC_CONTAINER* class, we can create containers by making a standard window call, as shown in Listing 1.

Here, we are creating a container with the control styles of *CCS_AUTOPOSITION* and *CCS_EXTENDSEL*. To specify the attributes we desire for the container, we need to populate the *flWindowAttr* field of a *CNRINFO* structure and pass this structure to the container on a *CM_SETCNRINFO* message. This can be seen in the example immediately following the creation of the container. It looks similar to Listing 2.

In this example, we are changing the attributes on the container and putting a title within the container. A pointer to the populated *CNRINFO* structure is in the first message parameter. This is where we have populated two fields, *flWindowAttr* and *pszCnrTitle*, with the attributes we've selected and a pointer to the title we wish to display.

The second message parameter is where we tell the container what fields within the *CNRINFO* structure we've updated. As a programming habit, I would recommend querying the container for the current *CNRINFO* by sending it a *CM_QUERYCNRINFO* message before replacing it. With that, we've created a basic container that has a title.

Now that we have a basic container, let's put some records in it. Before we can do this, we need to define a record structure that we can use for examples. My example is shown as the structure in Listing 3. This structure is pretty simple with one unique structure within it, *RECORDCORE*. It links our world and the world of the container. It is very important that this be the first area within our sample record structure.

By making it first, a pointer to our record doubles as a pointer to a record core structure that the container desires and a pointer to a *SAMPLERECORD* that we desire. This is not the only type of *RECORDCORE*. Actually, two types of *RECORDCORE* structures exist. The other is a *MINIRECORDCORE*, a simpler and smaller version of *RECORDCORE* that allows for only one icon and

LISTING 3.

```
typedef struct _samplerecord {
                        RECORDCORE  recordcore;
                        HPOINTER    hptrIcon;
                        PSZ         pszString;
                        ULONG       ulNumber;
                        CDATE       cdate;
                        CTIME       ctime;
                        } SAMPLERECORD, *PSAMPLERECORD;
```

LISTING 4.

```
/* ask the container to allocate a region for us */
size = (LONG) (sizeof(SAMPLERECORD) - sizeof(RECORDCORE));
psamplerecord = WinSendMsg ( hcont
                , CM_ALLOCRECORD
                , (MPARAM)size
                , (MPARAM)1 );
```

one piece of text associated with all the basic container views.

To use *MINIRECORDCORE* instead of *RECORDCORE*, you just specify the *CCS_MINIRECORDCORE* style bit when the window is created. The other fields in the structure define all the other data we wish to display.

When adding a record, the first thing we need to do is ask the container to allocate space for it. Listing 4 shows how to send the container a *CM_ALLOCRECORD* message with the additional size we need allocated for our information.

The example does this for one record, but several records could have been asked for if needed. We can then populate the returned area with the appropriate data, which includes populating the appropriate fields within the *RECORDCORE* structure. The example loads an icon, populates the string, date, and time fields, and then initializes some of the fields in the *RECORDCORE*.

Before we can add the record, we must tell the container where and how to add it. This is done with a *RECORDINSERT* structure. This area will tell the container where you wish the desired record to be placed (in the front or back) and how many records you are inserting.

We can now send a *CM_INSERTRECORD* to the container, passing it the pointers to these two structures. You can see all of this in the *ADDRECORD* function within the example. *ADDRECORD* allocates the space for one additional record, initializes both structures, and inserts the record with the call shown in Listing 5.

Here, *hcont* is the handle to the container, *CM_INSERTRECORD* is the message, *psamplerecord* is a pointer to the sample record we wish to insert, and *rci* is the *RECORDINSERT* structure defining how we wish this record inserted.

Deleting records

Deleting records is even simpler than adding them. We send a *CM_REMOVERECORD* to the container with three pieces of information. First is a pointer to the array of *RECORDCORE* structures to be removed. Second is the number of pointers. If zero is passed, all the records in the container will be deleted. Third are the flags telling the container how to remove the records. *CMA_FREE* tells the container to automatically free the storage used by *RECORDCORE*. *CMA_INVALIDATE* is the other flag. It tells the container what should be done with the remaining records in the container, whether they are invalidated, and if any repositioning should occur. The example deletes all selected records from the container, freeing them along the way.

Deleting records introduced us to a new area: querying the container and the current emphasis of its records. A record within a container can have three types of emphasis: cursored, which has a little dotted box around it; in-use, which has diagonal hashing through it; and selected, which is highlighted. The container takes care of the cursored and highlighted attributes for us whenever we click within it and automatically applies the selection style to update the record's current state. In-use messages must be sent by the application program by sending *CM_SETRECORDEMPHASIS* for the record in question to the handle of the container. This is usually done whenever a record is double clicked to give visual feedback that the double click has been received and is being processed.

At this point, we have a fully

functional container to which we know how to add, delete, and emphasize records, but we haven't added the user interface to know when we wish to do this. A pop-up menu will be our answer. When the user requests a menu with a single click of the minor mouse button (the right mouse button for right-handed people), the container receives a *WM_CONTEXTMENU* request, which it passes on to its owner in the form of a *WM_CONTROL* message *CN_CONTEXTMENU*.

With this message, you also get the ID of the container sending this message and a pointer to a *RECORDCORE* structure over which the mouse operation occurred. If this action occurred over empty space (usually called white space), this pointer will contain a null value.

The pointer is the key item. With it, we can interrogate the record and pop up a different menu for each record in the container if we wish. The actual menu is displayed with a *WinPopupMenu* call. To use this function, we must have first loaded or created a handle to a menu using *WinLoadMenu* or *WinCreateMenu*. This is demonstrated in the sample program.

It receives the *CN_CONTEXTMENU*, saves the pointer that the request is made for, and pops up the menu. The menu handle that is used for this request was first loaded in the *WM_CREATE* process with a *WinLoadMenu* call. Because the example has a homogeneous set of sample records, it only loads and pops up one type of menu.

By taking a look at the menu contained in the sample, we see that it does more than just add and delete records. It also allows us to change the view of the container. By default, the container gives us five views: icon, name, text, detail, and tree. Icon and name view are basically the same, just arranged a little differently. They both provide for an icon and some text to be displayed either underneath or beside the icon. Text view is even simpler. It displays only the text associated with record.

Other views

Detail and tree view are a little more complex. With tree view, you must define the parent of the record you are inserting by supplying a pointer to its *RECORDCORE* and a *TREEITEMDESC* structure, which contains handles to the bitmaps or icons that are to be used in the expanded and collapsed states. This is demonstrated by the OS/2 drives object. Detail view is probably the most complex. With it, you must define the number of columns to be displayed and the actual column information.

All these views need not display the same text. The text displayed in the name view need not be the same text displayed within the tree or text views. This allows for quite a bit of customizing.

Another item in the menu of the example is a choice to *Arrange*. If we were to remove the style bit *CCS_AUTOARRANGE*, our objects would always be added to the same coordinates as specified on the *CM_INSERTRECORD* message, and our deletes would leave holes where removed records were displayed. Even if we resized the window, the objects would stay in their current positions. Selecting this option (*Arrange*) would cause the icon view of the container to arrange itself, filling the container from left to right, top to bottom.

If the icons ever get out of order, we could realign them with this function. With *CCS_AUTOARRANGE*, this choice should never be necessary, as the icons would arrange themselves automatically, but it has been included just to make sure.

The example creates all of its detail view in one function. It starts off by asking the container to allocate space for the columns to be displayed, as shown in Listing 6.

In this case, the container has five columns. Returned is a pointer to a linked list of *FIELDINFO* structures that we use to delineate the columns. In defining these columns, we must remember that there are five basic types: bitmaps or icons, strings, numbers, dates, and times. The type of column depends on which attribute is specified in the *flData* field of the *FIELDINFO* structure.

We can also specify whether or not this field is separated from others, whether it's read-only, how its text should be displayed (horizon-

LISTING 5.

```
WinSendMsg ( hcont
           , CM_INSERTRECORD
           , (MPARAM)psamplerecord
           , (MPARAM)&rci );
```

LISTING 6.

```
pfi = WinSendMsg ( hcont
          , CM_ALLOCDETAILFIELDINFO
          , (MPARAM)NUM_COLS
          , NULL );
```

tally and vertically), and whether or not the column is visible. If the column is set to handle strings, the user may directly edit this field by pressing the Alt key at the same time as the major mouse button (left button for right-handed people).

This editing capability can be turned off by simply specifying *CFA_FIREADONLY* in the *flData* field of the *FIELDINFO* structure. The next field, *flTitle*, is where the attributes for any titles to be displayed are specified. Standard right, left, and center for horizontal and vertical positioning are available, but the title does not have to be text. If the attribute *CFA_BITMAPORICON* is set, the column heading can be a picture instead of words.

Another field in the *FLDINFO* structure is the *cxWidth*. This is where a fixed width is given to a column. If no value is specified, the container will automatically size the column to the length of the largest field in the column. After all the *FIELDINFO* structures have been initialized (the date and time columns use the *CDATE* and *CTIME* layout), we use another structure to tell the container where these columns are to be inserted. This would be the *FIELDINFOINSERT* structure. It tells the container where to insert the columns and whether or not to redraw the container after inserting them. Now, it's just a matter of sending the container a *CM_INSERT* message with the proper pointers (one to the first *FIELDINFO* and another to the *FIELDINFOINSERT*), and it will return the number of *FIELDINFO* structures in the container.

The example adds one more item to the container, a vertical split-bar. A split-bar divides the container into two windows that can be scrolled independently whenever the container is in detail view. It can also be moved horizontally to resize both windows. This is very helpful when some type of reference information is needed while scrolling through a long list of columns. To add a vertical split bar to a container, you must specify the horizontal distance relative to the origin of the container to position the split-bar and the last column in the left half of the detail view. The vertical split-bar is added after the first column with the *CM_SETCNRINFO* message.

Another point of interest is that the example or what's shown in the example allows direct editing of the string field. To begin the direct editing, the user holds the Alt key down while pressing the major button on the mouse over the string field of a record. When this occurs, the container sends the program *CN_BEGINEDIT*, *CN_REALLOCPSZ*, and *CN_ENDEDIT* messages.

The *CN_BEGINEDIT* informs the program that direct editing of a field is starting. Once a direct editing session has started, no messages should be sent to the container until after the *CN_ENDEDIT* message has been received. Unpredictable results may occur if we do otherwise. When the editing session is about to close, we receive *CN_REALLOCPSZ* and can test to see if there is sufficient memory for the container to copy the new string over the old string. The example then *frees* the old string and *mallocs* a new area to accept the new string. If we were to return *FALSE* instead of *TRUE*, the new string would simply be discarded by the container. *CN_ENDEDIT* means that the edit session has finished, and we should update our container contents with the new value. We can once again send messages to the container.

Highlights

As you can see, the container is one of the most versatile controls offered. Myriad displays can be achieved through a relatively simple set of interfaces while, at the same time, limiting the dependence of the visual display on the physical data. It also opens a new area of interface design, giving users the capability to directly control their environment. I have briefly covered a few container highlights here, but this is not where it ends. Other areas such as drag and drop, sorting, filtering, and displaying mini-icons are definitely worth exploring. ■

Randy Branham is a consultant who has developed three-tiered development environments for five years. For the last 18 months , he has devoted his efforts entirely to OS/2 2.0. He can be reached on CompuServe at 71044,137.

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Notebook Bene

The notebook control is an innovative way to group collections of windows. Here's a step-by-step guide to programming it.

by Paul Montgomery

The notebook control was included in OS/2 2.0 to provide a mechanism for creating logical groupings of information and actions. Visually, the notebook resembles a spiral or hardbound book with tabs placed along the edges as indexes. Users can click on one of these tabs and go directly to the position in the book it represents.

To programmers, the notebook is a control that manages the Z-ordering of a set of windows. This control can be created and positioned just like any other control under OS/2. Its intent is generic; its use by programmers provides its usefulness and meaning to users.

I'm assuming that readers are familiar with Presentation Manager programming in general and have available the IBM C/Set 2 compiler and IBM OS/2 2.0 Toolkit.

What's a page?

A page in the notebook is actually a window defined by the programmer. The notebook controls the visibility of each window based on user selection of that page. The window is sized and positioned by the notebook control to take up the entire visible page whenever a user selects the page it represents.

The window can be anything from a simple control to a very complex window containing many other windows. The content of these windows is what gives meaning to the notebook. Take the OS/2 Desktop's settings notebook. This notebook is a collection of configuration options for the OS/2 desktop. Each page represents a different aspect to configure.

Some pages have groups of things, others have a single item. For instance, the View page is used to configure how the icons are displayed on the desktop. It has six radio buttons grouped into two group boxes, a font change group box, and a series of three buttons across the bottom.

All of these are placed on a frame window. This page could have been a dialogue brought up in response to a selection on a menu, but the designers concluded that

LISTING 1.

```
static HWND CreateNotebook(HWND parent,HWND owner,ULONG id,ULONG style)
   {
   HWND hbook;

   // Create the notebook and return its handle to the caller.
   hbook = WinCreateWindow( parent
            , WC_NOTEBOOK
            , ""
            , style
            , 0, 0
            , 0, 0
            , owner
            , HWND_TOP
            , id
            , 0
            , 0
            );

return hbook;
}
```

LISTING 2.

```
pwd->hbook = CreateNotebook ( hwnd
             , hwnd
             , NOTEBOOK_ID
             , BKS_SPIRALBIND
             | BKS_BACKPAGESBR
             | BKS_MAJORTABRIGHT
             | BKS_ROUNDEDTABS
             | BKS_STATUSTEXTLEFT
             | BKS_TABTEXTLEFT );
```

this page represented only one set of selections a user would have to make to configure the desktop. So they decided to group all the dialogues together into a notebook and let each page collect different categories of information.

Using a programmer-defined window for each page is a very powerful concept. By doing so, a page is only limited by the items that can be contained within windows, and, in Presentation Manager, that is anything.

For example, a notebook could be a collection of applications with each page being a different application. Or the notebook could be a dictionary with a tab for each letter of the alphabet. You could even use the notebook as a channel changer for a set of video windows. Each tab represents a different channel or selection of video. The notebook could be a portfolio of clip art with each page being one or more drawings. You could have the major tabbed pages be a description of the clip art to follow and the minor tabbed pages be the individual pieces of clip art. To do this, you would need three simple types of windows: a text window (really a window with an MLE on it), an art window (just a window with the *WM_PAINT* processing, putting a bitmap in the window), and a main client window that contains the notebook, creates the pages, and tells them what to display. The cover of the notebook (that is, the first page of the notebook) would also be a text window with an explanation of the contents of the entire notebook.

Creation of the notebook

The notebook control is a window like any other control under OS/2 (for instance, a button, a container, or a list box). It is created with a call to *WinCreateWindow* with the *pszClassName* parameter set to *WC_NOTEBOOK*. The notebook expects the *flStyle* parameter of the *WinCreateWindow* call to be filled with a set of flags that determine the visual aspects of the notebook. For instance, do you want a spiral or solid binding? Is the binding on the left, right, top, or bottom? Where are the tabs? They need to be on a different side from the binding. Are the tabs square? Rounded? Polygons? For this example, I will create a notebook with a spiral binding on the left and the major tabs on the right. The tabs will have rounded corners and the text in the tabs will be left-justified.

I have created a set of functions used to interact with the notebook. The first of these functions is *CreateNotebook*. It is shown in Listing 1.

The size parameters for the notebook are zero at this point. During the processing of the *WM_SIZE* message, the notebook will be sized to the current size of the client area of the window. This function is called with the parameters shown in Listing 2 to create this notebook.

The value returned in *pwd->hbook* is the *HWND* for the notebook. This call is done in the *WM_CREATE* processing of our main client window. We also want to set up a default size for the tabs in the notebook. This is done through the *BKM_SETDIMENSIONS* message.

We will set up a default size for the tab of 10 characters wide and a single character high. The tab size is based on the font metrics of the current font for the client window. This is obtained through a GPI call *GpiQueryFontMetrics*.

The *FONTMETRICS* structure obtained through this call has two fields that we need. One (*lMaxBaselineExtent*) we use for the height

LISTING 3.

```
BOOL SetTabDimensions(HWND hnb,USHORT width,USHORT height,USHORT type)
{
   return (BOOL) WinSendMsg ( hnb
                  , BKM_SETDIMENSIONS
                  , MPFROM2SHORT ( width, height )
                  , MPFROMSHORT ( type )
                  );
}
```

LISTING 4.

```
ULONG MakeNotebookPage(HWND hnb,ULONG pageid,USHORT style,USHORT order)
{
 return (ULONG) WinSendMsg ( hnb
         , BKM_INSERTPAGE
         , (MPARAM) pageid
         , MPFROM2SHORT( style, order )
         );
}
```

of the tab. Another *(lAveCharWidth)* we multiply by 10 to get the size of a 10-character-long tab. We then send the *BKM_SETDIMENSIONS* message to the notebook with a value of *lMaxBaselineExtent* for *usHeight* and a value of *(10 * lAveCharWidth)* for *usWidth*. *usType* is set to *BKA_MAJORTAB* for this call. We can then repeat the call for the minor tabs by just changing the *usType* message to *BKA_MINORTAB*.

In Listing 3, I have created a function, *SetTabDimensions*, to send the message to the *BKM_SETDIMENSIONS* message and on to the notebook. The width, height, and type parameters are set as I described previously. Once we have created the notebook, we are now able to insert pages.

Inserting a page

Inserting a page into a notebook is a multistep process. First, you must tell the notebook that you want to insert a page and where you want it inserted. You then associate a window with that page. After the page is inserted, you can give the tab a value or associate user data with the page. If you discover that the tab size you set up is not large enough to hold the text or bitmap you want, you may also resize the tabs.

The message used to insert a page is *BKM_INSERTPAGE*. This message has two parameters in which three pieces of information are given. The first parameter contains the ID of the page to insert. This ID must either be the ID of a previously inserted page or *NULL*. The second parameter is a combination of two *USHORT*s. The first is called the page style. Style in this context means: do you want the page automatically sized (*BKA_AUTOPAGESIZE*), do you want a major or minor tab on this page (*BKA_MAJOR* or *BKA_MINOR*), and do you want the status line on the bottom of the page to be displayed (*BKA_STATUSTEXTON*).

The second *USHORT* is the page order. This allows the programmer to specify where, in relation to the page ID given in the first parameter, to place the inserted page. The values available for use here are *BKA_FIRST*, *BKA_LAST*, *BKA_PREV*, and *BKA_NEXT*. If *BKA_FIRST* or *BKA_LAST* are used, the page ID in the first parameter is ignored. If *BKA_NEXT* or *BKA_PREV* are used, the page ID must be a valid ID, and the new page is inserted relative to the page specified.

The two *USHORT*s are combined into one parameter through the use of the *MPFROM2SHORT* macro. The return from the *BKM_INSERTPAGE* message is the page ID of the inserted page. Once again, I have created a function, shown in Listing 4, to do the mechanics of the *WinSendMsg*. The function is called with the parameters in Listing 5 to insert the first page into the notebook.

In the example, the first page created is our title page. At this point, the page has already been inserted, so now we need to create the window that is associated with this page, a text window. The text window is registered as the window class *TEXTCLASS* in the main function in the example. The *TEXTCLASS* window just creates an MLE and fills it from a text resource.

I have set up a relationship between the ID of the window and the ID of the resource to retrieve from the resource file. The ID of the window is the ID of the tab text for the page, and ID +1 is the ID of the text resource to fill the MLE with. ID +3 is the ID of a string that contains the number of art windows following this page.

First, we create an instance of this window and give it the ID of the text resource that we want it to display in its MLE. This is done through the *WinCreateWindow* call shown in Listing 6.

Once the window is inserted, the *BKM_SETPAGEWINDOW* command is used to associate a programmer-created window with the page. The message takes two parameters. The first is the page ID returned from the insertion of the page, and the second is the handle of the window. This is done with the function *SetNotebookPageHwnd*

shown in Listing 7, which is called with the parameters in Listing 8.

Now that we have a page with a tab, we need to tell the notebook what text to put on the tab. The tab text is added with the *BKM_SETTABTEXT* message. This message also takes two parameters. The first is the ID of the page to change the tab text on. The second is the text string to use. If the text you use for the tab is too long to fit in the space provided, it is truncated.

Where it is truncated depends on how you have configured the alignment of the text (this was done in the style flags during the creation of the notebook) and the size you have created for the tabs. For example, if you have used *BKA_TABTEXTCENTER* for the alignment, both ends of the text may be truncated. So at this point, we may need to send a *BKM_SETDIMENSIONS* message again to enlarge the tabs to fit the new text.

This process continues for each of the text pages and art pages.

LISTING 5.

```
// insert a page into the notebook
pageid = MakeNotebookPage ( hbook
   , NULLHANDLE
   , BKA_AUTOPAGESIZE | BKA_MAJOR
   , BKA_FIRST
   );
```

LISTING 6.

```
hTitlePage = WinCreateWindow( parent
           , "TEXTPAGE"
           , ""
           , WS_VISIBLE
           , 0, 0
           , 0, 0
           , owner
           , HWND_TOP
           , id
           , NULL
           , 0 );
```

LISTING 7.

```
BOOL SetNotebookPageHwnd ( HWND hnb, ULONG pageid, HWND hpage )
   {
   return (BOOL) WinSendMsg ( hnb
            , BKM_SETPAGEWINDOWHWND
            , (MPARAM) pageid
            , (MPARAM) hpage
            );
   }
```

When an art page is being inserted, we change the *BKA_MAJOR* in the page style to a *BKA_MINOR*, and we create a window of class *ARTCLASS*.

Interaction with the notebook

Once we have all the pages inserted into the notebook, the interaction with it becomes very simple. When users press a tab on a notebook, it sends a *WM_CONTROL* message with a notify code of *BKN_PAGESELECTED* to its owner (our client window). The *notifyinfo* field of the message points to a *PAGESELECTED* structure. This structure contains the handle of the notebook sending the message, the ID of the page being left, and the ID of the page being brought to the front.

The owner window can send any messages to the windows associated with these pages to notify them of the change. Owners can use this message to keep track of what page is on top, determine when to go get more data, or perform any other action that comes to mind. In our example, we do not need to track which window is on top so the program does nothing with this message. In fact, this application has nothing to do until the user closes the notebook. What could be simpler?

When a notebook is destroyed, any pages that are still in the notebook are destroyed, too. No notification is given that this is happening. It is up to the owners to remove the pages if they don't wish the window associated with the pages to be destroyed. It is also up to owners to delete any resources they may have associated with a page. Each page should also be able to handle the *WM_DESTROY* message and free any resources it may have allocated. Failure to do this will cause resources to stay around until the process is closed.

LISTING 8.

```
SetNotebookPageHwnd ( hbook
                    , pageid
                    , htitlepage );
```

Programmers can find complete definitions of the messages that a notebook can send and receive in the IBM Programmers Toolkit Presentation Manager Programming Reference on-line reference or in the *IBM OS/2 Technical Library* in printed form. ■

Acknowledgements

I would like to thank IBM for the work it has done to make OS/2 2.0 the outstanding product that it is. The notebook control is but one example of the enormous amount of effort and thought the programmers and designers at IBM have put into OS/2. A lot of people at IBM have put heart and soul into this product, and I think they deserve every accolade that can be accorded to them.

Paul Montgomery is president of TASP Group Inc., which specializes in OS/2 consulting and programming. He can be reached on CompuServe at 71500,3525.

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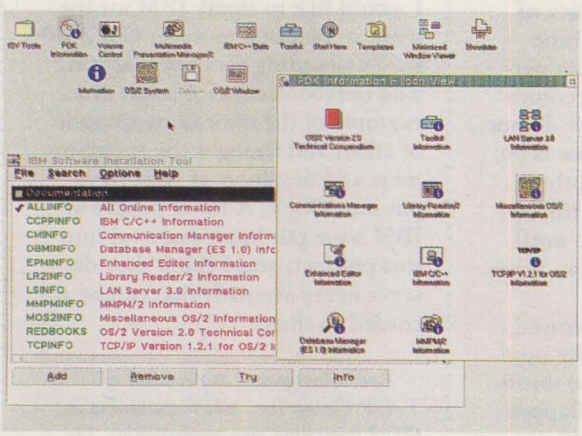

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Chris Corry

Preview ++

Pity the OS/2 programmer. For the last couple of years, OS/2 has been treated like the Rodney Dangerfield of the software industry, and the phenomenal success of Windows has only made things more frustrating for OS/2 developers. With the majority of resources being poured into DOS, Windows, and Windows NT, OS/2 programmers have traditionally been saddled with a host of lackluster development tools and compilers.

Since the introduction of OS/2 2.0, things have started to change, and now I am happy to say that the OS/2 developer's proverbial ship is about to come in. Shortly, Borland and IBM will be unleashing their new C++ compilers, and OS/2 application development will never be the same. These products promise to deliver the same high-end features and performance currently only available under DOS and Windows.

As of January 1993, both products discussed here were in beta test and not expected to ship for several months. Products in beta test are typically dynamic creatures whose feature sets or components are subject to alteration (or even radical changes) at any time preceding the ship date. It would appear that these compilers are pretty far along, and the odds of any major changes being made to either product are slim.

Borland C++ for OS/2

Fans of Borland's C++ for Windows will immediately recognize the OS/2 version as a direct descendent. The product is amazingly complete, considering that every aspect of the system was written from scratch to take advantage of OS/2 2.0's 32-bit architecture and advanced operating system services. The base package includes an integrated development environment (IDE), a Presentation Manager (PM) hosted version of Turbo Debugger, the Resource Workshop, a command-line compiler, linker, and a host of smaller utilities and tools.

The compiler (which is the same for the command-line version and IDE) allows programmers to build full-fledged 32-bit programs that operate in text mode or as native PM applications. Unlike the IBM product, Borland does not support the development of virtual device drivers.

The Borland compiler includes support for standard ANSI C, and its C++ implementation is based on the AT&T cfront 2.1 specification. Borland provides full support for templates, a C++ construct allowing for the creation of generic classes that manipulate anonymous data. However, exception handling, an important feature just starting to show up in C++ compilers, is not supported. Precompiled headers are available in the command-line and IDE versions of the compiler.

As you would expect, the package supports programming of OS/2's advanced features, including multithreading and dynamic link libraries. The full PM API set is covered, including the new extensions added to support the Workplace Shell. Borland also includes a set of IBM developed precompilers and utilities that allow you to build system object model (SOM) applications. SOM is a powerful, new, object-oriented programming mechanism that allows for language-independent development, extension, and use of classes between compilers.

The IDE that comes with Borland C++ for OS/2 is an impressive

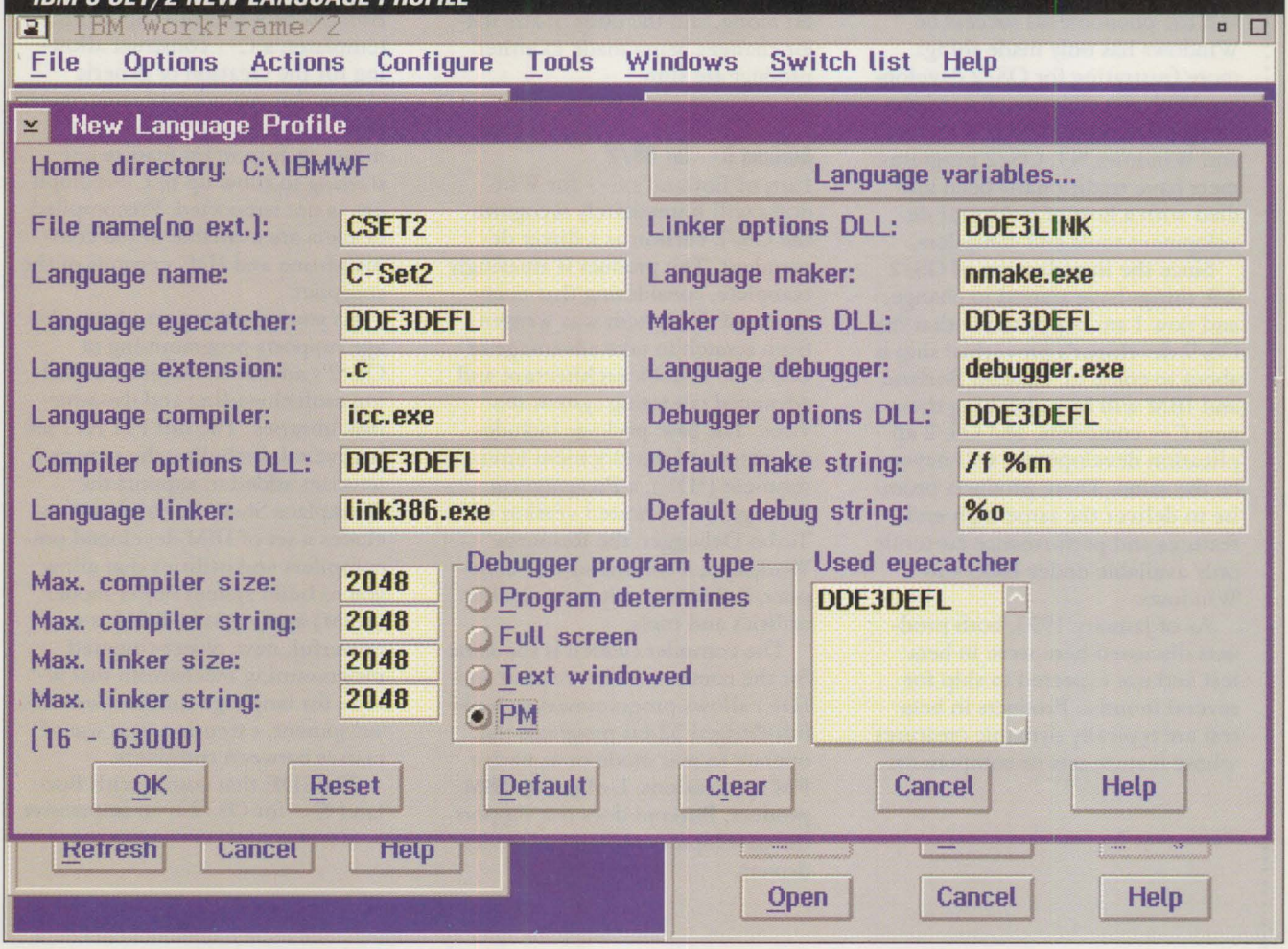
programming environment and a faithful port of the Windows product. A casual survey of the IDE reveals the obligatory toolbar (Borland calls them SpeedBars), project and edit windows, and an integrated debugger. The OS/2 IDE also includes a number of important features that differentiate it from its Windows-based sibling. Because OS/2 is a multitasking operating system, the OS/2 IDE allows developers to start tasks and let them execute in the background. It is a tremendously convenient feature, and users will rapidly become accustomed to kicking off background operations and immediately moving on to the next task.

The IDE extensively uses the Workplace Shell convention of displaying pop-up menus when the right mouse button is clicked over a window. This ability provides the user interface with an exceptional amount of flexibility. For example, to save the current file, you can select the *Save* option from the main file menu, use the appropriate accelerator key combination, click on the toolbar, or bring up the pop-up menu for the selected edit window.

The integrated editor is standard Borland fare. In addition to the standard Borland key bindings, Borland provides alternative keyboard mappings that provide Brief, Epsilon, or CUA behaviors. A keyboard definition compiler is also provided that allows you to build custom keyboard layouts. In practice, however, creating an emulation of your favorite editor can be a trying experience that requires perseverance and a good understanding of the IDE's macro language.

Syntax highlighting allows certain elements of your source code to be displayed in different colors while editing. For example, you can set variable names to appear in blue while displaying reserved words in red. Displaying your code in this manner lets you catch typos and simple mistakes at a much earlier stage of the development cycle—but be prepared for an adjustment period. I definitely found the multicolored source window to be an acquired taste.

IBM C SET/2 NEW LANGUAGE PROFILE



Like its siblings, the IDE completely does away with *makefiles*. Instead, the programmer creates projects that seamlessly automate the generation of internal dependency lists. Because the IDE takes care of these things under the covers, any changes made to source code will only force the recompilation of those modules that need it.

I was surprised to find that the excellent class browser built into the Windows IDE is absent from the first version of the OS/2 product. A browser allows the programmer to inspect individual class characteristics and call up the source code for specific class methods by clicking on a hierarchy diagram. Although Borland has indicated that the browser will make an appearance in a future version, its exclusion from the first release is disappointing.

The version of Turbo Debugger that ships with the compiler looks unlike any other debugger from Borland. It is a fully graphical application that runs as a native PM program. Like the IDE, it makes judicious use of toolbars and pop-up menus. The debugger allows large, multithreaded programs to be tracked from the central window. Threads can be individually traced, suspended, and resumed. Breakpoints and watchpoints are easily set. The debugger also allows you to stop execution after a PM program has received a particular message in its message queue. OS/2 exceptions can be passed onto the program or trapped so that the state of the program can be evaluated in a post-mortem fashion.

Debugging programs with TD is simple and almost enjoyable. It is, however, very easy to find yourself with many windows open at the same time. When you add your program's windows to the equation, the screen clutter can be annoying on a high-resolution screen and downright obnoxious at standard VGA resolutions. I suppose if you want to look at a dozen different things at the same time, you better be prepared to have a dozen windows open on your screen. Regardless, a higher-resolution screen is definitely recommended.

Borland C++ for OS/2, despite all of its similarities to the Windows version, is lacking several key components that have helped to make the other professional Borland C++ products so successful. Notably absent are the Object Windows Library (OWL) and Turbo Vision applications frameworks. Because Turbo Vision is a collection of classes that only support the creation of full-screen text mode user interfaces, this omission should cause little concern.

The lack of support for OWL, however, is a little more significant. The OWL libraries for Windows are a collection of user interface classes that provide comprehensive support for many of the Windows APIs. OWL has proven to be very popular, and many developers use the libraries exclusively for all GUI programming. Programmers who have a large amount of OWL-based code will have to wait until the OWL libraries are ported to OS/2 before they can migrate their applications. Borland is developing OWL libraries for OS/2, but there is no word yet on when they will be available.

Although none of the Borland applications frameworks is supplied with the product, the strong Borland container class libraries are included. The classes come in template form, with a set of explicit classes included to provide backward compatibility with previous versions of the library. Included in the library are classes to implement lists, stacks, queues, dictionaries, binary trees, and iterators, to name just a few.

IBM Corp. C Set/2 v. 2.0

When IBM first introduced OS/2 2.0, it shipped a comprehensive development environment that centered on the C Set/2 compiler. This sophisticated compiler was subsequently used by virtually every OS/2 developer, not only because it was the only 32-bit OS/2 compiler shipping but because it also proved to be a competent performer. Any compiler vendor that wants to challenge IBM will have to penetrate this significant installed base, and IBM is not sitting on its laurels. IBM's languages division in Toronto, Ont., Canada, is now preparing the next release of C Set/2 that, as it turns out, is a very capable C++ compiler. The new version of the product includes the command-line compiler, linker, updated graphical debugger, class browser, profiler, and a number of smaller support programs and libraries.

Borland has always been in the position, at least when its primary competitor has been Microsoft, of having the most robust and complete C++ implementation on the market. IBM, however, has leapfrogged Borland by providing full exception handling in addition to ANSI X3J16 (up to the June 5, 1992 working draft) compliance. Exception handling provides a tremendously powerful way to capture and process abnormal program events. Unlike some other implementations of exception handling that rely on a simple *setjmp/longjmp* mechanism, the IBM exception-handling support reliably ensures that class destructors are called when an exception forces an object instance out of scope.

The compiler, not surprisingly, resembles the original IBM C Set/2 compiler in both form and function. In addition to the significant C++ implementation, however, a few welcome additions have

been made to the compiler since the initial release. For example, all run-time library functions are now re-entrant, which means that functions such as *sprintf* can now be safely used in multithreaded programs. Previously, developers working on multithreaded applications had to shy away from using particular library calls or risk encountering some very frustrating debugging sessions.

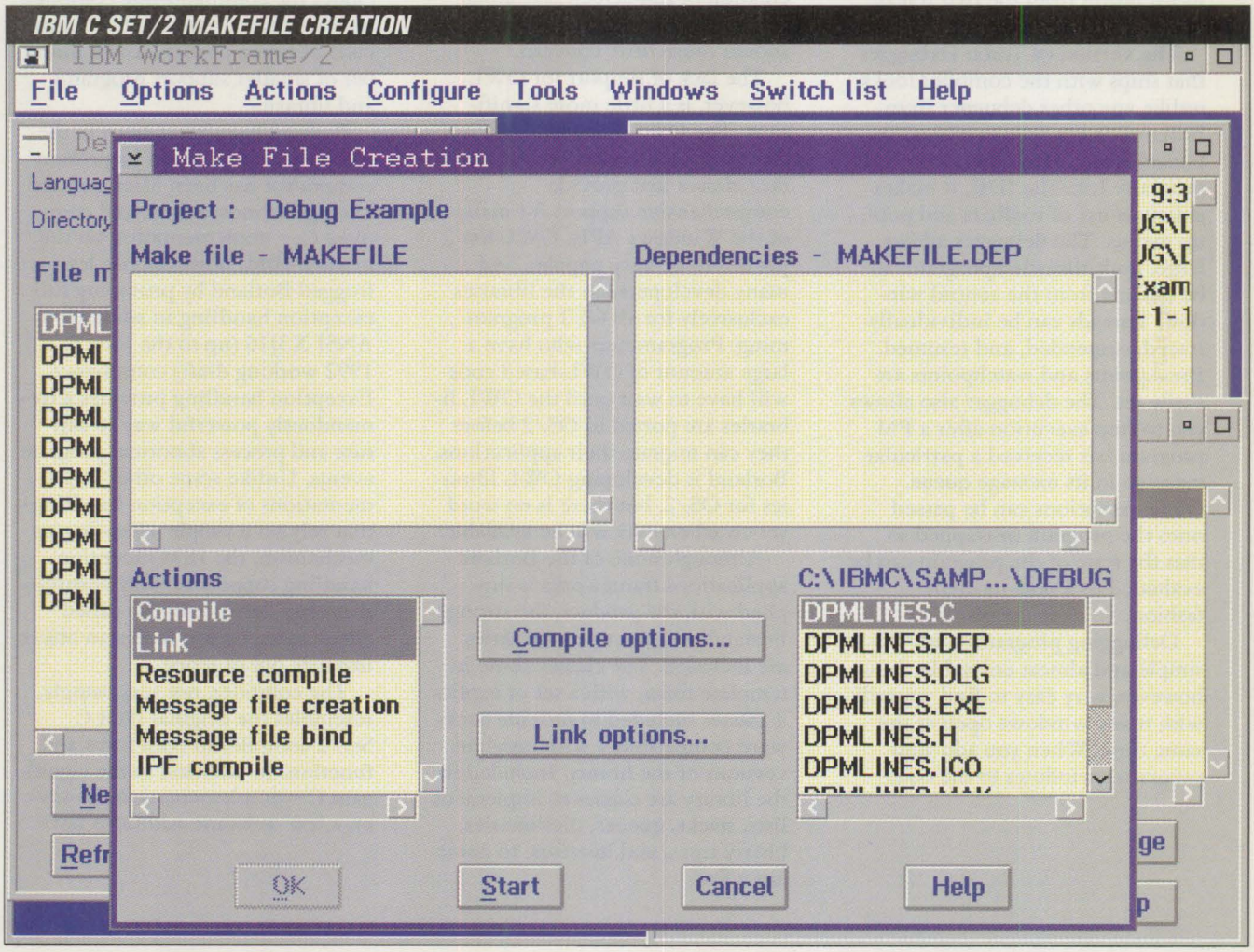
There are, also, a number of new compiler options. One intriguing compiler switch optimizes your code to run on Intel's forthcoming Pentium (586) chip. Another controls the use of precompiled headers. The IBM compiler also provides excellent floating-point support in the form of IEEE 80-bit long double types.

If you want to develop PM programs with this C++ compiler, you will need to purchase the IBM OS/2 Developer's Toolkit, which is available separately. Support for SOM, however, is supplied with the compiler and requires no additional components (although the creation of SOM objects that use PM will require the toolkit).

IBM's IDE design strategy diverges sharply from Borland's. While Borland has chosen to build its compiler directly into its IDE and bind its development tools into a single environment, IBM has chosen the completely opposite approach. The WorkFrame/2 product, sold separately from the compiler, is a general-purpose IDE. Out of the box, it does almost nothing. Instead, it provides a generic development environment framework into which the developer can plug virtually any third-party tool. This flexibility allows the WorkFrame to work with almost any compiler (even compilers designed for DOS or Windows), albeit not quite as smoothly as the Borland IDE.

One of the advantages to this strategy is that developers can use the editor of their choice. With the Borland IDE, however, you have little choice but to use the built-in editor or spend the time creating a keyboard map that emulates your

IBM C SET/2 MAKEFILE CREATION



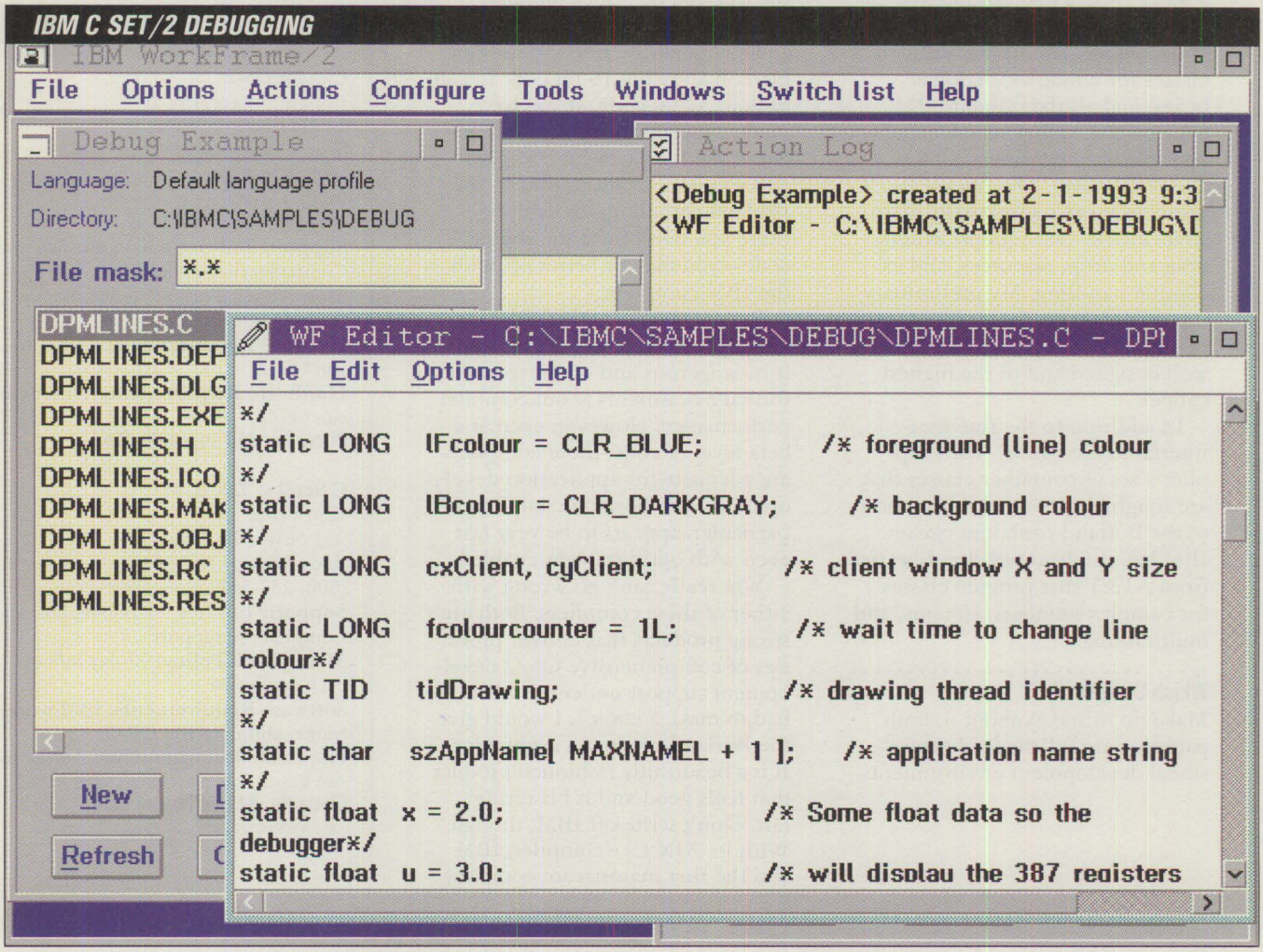
editor. Because most professional developers have an almost fanatical allegiance to a particular editor, I am sure that many will prefer the WorkFrame approach over Borland's. Also, Borland provides the necessary dynamic link libraries to integrate its compiler into the WorkFrame.

The downside to the WorkFrame's philosophy is that even the most WorkFrame-aware compiler and tools don't feel as closely coupled as the tools in the Borland IDE. Depending on the capabilities or limitations of your editor, for example, you may not be able to click on error messages and go to the appropriate line in your source code. Even WorkFrame *makefile* creation, which in many ways mimics the Borland environment, is more difficult and feels a little less polished.

Unfortunately, neither the WorkFrame nor Borland IDE is seamlessly integrated into the Workplace Shell. Despite all their respective strengths, they still look and feel more like OS/2 1.x applications. IBM has hinted that a Workplace-Shell-oriented version of the WorkFrame is under development, and developers at Borland have commented that more complete Workplace Shell integration is being considered for the next product release.

Borland's Turbo Debugger resembles IBM's IPMD debugger in many ways, and it is probably safe to assume that the original IPMD tool served as an inspiration for the Borland development team. This version has been significantly overhauled with a number of new features, the most significant, of course, being the support for programs written in C++. The new release also adds convenient toolbar-like buttons to source windows (although the icons used in my beta version made it difficult to decipher what each button did) and replaces the traditional code windows with a notebook control that lets you easily flip between different source modules.

Probably one of the nicest features of IPMD is its monitor win-



dow that displays the value of various tokens as you inspect them. Aggregate constructs (classes, structures, and unions) that contain other elements can be collapsed or expanded depending on the level of detail you are interested in seeing. The user interface is not as polished or usable as Borland's Turbo Debugger, and there are gaps in IPMD's capabilities (setting automatic breakpoints on PM messages, for instance). Still, the IPMD debugger is a good tool that should be more than adequate for anything but the most demanding debugging tasks.

One of the most exciting aspects of the IBM compiler is the comprehensive set of PM class libraries that come with the product. The IBM user-interface library provides a set of classes that abstract the entire messaging model that PM operates under. The library delivers classes for windows, dialogue boxes, and all the standard PM controls (including new OS/2 2.0 controls like containers, sliders, and notebooks). The library also provides more conceptually abstract classes that support events, drag and drop, resources, and exception handling. My preliminary experiences with these classes indicate that the library is exceptionally well designed and of the highest caliber.

In addition to the fine user-interface class library, IBM supplies a set of container classes that are roughly equivalent in function to the Borland container classes. IBM has also licensed class libraries from AT&T that provide classes for complex numbers, streams, and multitasking.

Which Compiler?

Make no mistakes about it, both packages are full-fledged professional development environments. If you are looking for a cheap, hobbyist compiler, I suggest you look elsewhere. If, on the other hand, you are a professional developer who depends on programming OS/2 for your bread and butter, you will want to invest in one of these compilers. You should also take a close look at these offerings if you are responsible for purchasing tools for a corporate development shop or in-house programming department.

So which of these systems promises to be the stronger product? One thing to take into account when making your decision is compatibility. The IBM compiler fully supports interaction with older 16-bit code compiled for OS/2 1.x, including 16-bit functions calling back to 32-bit functions. Although the Borland compiler supports similar interactions with 16-bit code, at deadline Borland did not plan on allowing 16-bit code to call back to 32-bit code. If you have made a substantial investment in C Set/2 v. 1.0 or a 16-bit compiler and you don't want to port to the Borland compiler—or can't because you don't have the source code—you may be better off with the IBM compiler.

Because both of these products are only available in beta versions, it is dangerous and unfair to make formal assessments about compiler performance. However, even at a beta level of code, these compilers are adequate for application development. The Borland compiler, in particular, appears to be very fast even with optimizations enabled.

You really can't go wrong with either of these compilers. Both are strong products that deliver promises of comprehensive OS/2 development support under C++. If I had to make a choice, I would give the Borland product a slight edge. It is a beautifully fashioned product that feels good and is blistering fast. Don't write off IBM, though. With its AIX C++ compiler, IBM was the first mainstream company to ship a compiler that fully supports C++ exception handling. Now this capability will be available to the PC programmer. And, although the container classes that come with each of the compilers seem equal in scope, the IBM compiler wins the class library crown with its comprehensive PM user interface classes. It looks like OS/2 programmers are about to be faced with a no-lose proposition—finally. ■

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